50X1-HUM

CLASSIFICATION CONFIDENTIAL CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY REPORT

INFORMATION FROM

FOREIGN DOCUMENTS OR RADIO BROADCASTS CD

COUNTRY	USSR	DATE OF INFORMATION	1949
SUBJECT	Scientific - Electrical equipment		
HOW PUBLISHED	Monthly periodical	DATE DIST.	31 Jan 1950
WHERE PUBLISHED	Moscow	NO. OF PAGES	3
DATE PUBLISHED	Jul 1949		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE Elektrichestvo, No 7, 1949.

VOLTAGE STABILIZATION USING BARIUM TITANATE CONDENSERS

Prof G. I. Skanavi
Doctor of Physicomath Sci
M. D. Neyman, Engr
Physics Inst imeni Lebedev
Acad Sci USSR

In 1945 B. M. Bul and I. M. Gol'dman (1) showed that barium titanate has properties which are characteristic of seignetto-dielectrics. A condenser with a barium titanate dielectric is nonlinear, i. e., its capacitance depends on the voltage applied.

Nonlinear condensers can be used for various purposes. The work of V. P. Vologdin (2) and others (3) on the creation of a frequency multiplier is based on the use of these condensers. The frequency modulator and frequency converter (3) also provide examples of the use of seignettoelectric condensers as nonlinear elements of a circuit.

We have carried out investigations into the possibility of voltage stabilization based on barium titanate condensers. The idea of such stabilization is very simple and reduces to the following: an alternating voltage U is applied to two condensers in series, one, C_1, being linear (mica) and the other, C_2, being nonlinear (barium titanate). The voltage U divides in the inverse ratio of the capacitances. The capacitance of the condenser C_2 increases with the applied voltage. When the total voltage changes, e.g., if it increases, the voltage applied to the condenser C_2 will also increase, whereupon its capacitance increases and therefore the relative increase of voltage at the nonlinear condenser $U_2 = \frac{U}{\frac{C_2}{C_1} + 1}$ is less than the relative increase in the total voltage.

The first problem to be solved was that of selecting a material for the nonlinear condensers which would satisfy both the technical requirements and the need for the closest relation between the dielectric constant and the voltage. Commercially pure barium metatitanate has a very high sintering temperature.

CLASSIFICATION CONFIDENTIAL CONFIDENTIAL

STATE	X	NAVY	X	NSRB	DISTRIBUTION
ARMY	X	AIR	X	FBI	

50X1-HUM

CONFIDENTIAL

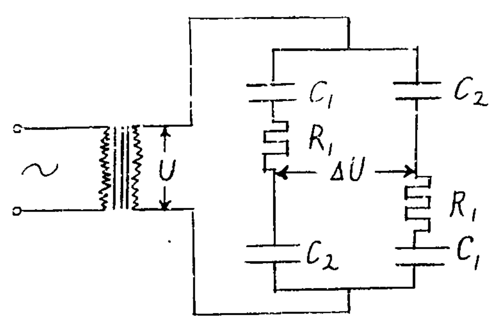
CONFIDENTIAL

The introduction of certain additives lowers the sintering temperature and alters the relationship. Increasing the additive content lowers the initial value of the dielectric constant and shifts the maximum of the dielectric constant-applied voltage curve towards the low voltage side. Consequently, the nonlinearity of the specimens with additives is considerably more pronounced and is manifested at lower voltages. The cause of this phenomenon is evidently the fact that the additives make the crystalline lattice more "porous"; the cohesion of some of the ions decreases and the nonlinearity and saturation effects are shifted towards the low voltage side. A material containing 1.5 percent additives was selected for the dielectric of the nonlinear condensers.

Experimental investigation of a circuit containing two condensers in series--one linear, the other nonlinear--disclosed that this scheme is impracticable. It does not give sufficient voltage stabilization even under no-load conditions. Moreover, putting a load in parallel with C_2 affects the voltage distribution, which results in additional deterioration of the stabilization.

At this point, a mathematical treatment is presented with the aid of the following graphs: capacitance and dielectric-loss angle of the barium titanate condensers (used in the experiments) versus voltage; voltage across C_1 and C_2 versus applied voltage; and (referring to circuit diagram below) the difference voltage ΔU versus input voltage U for different values of the linear condenser C_1 ($C_1 = 0.45$, 0.23, 0.20, 0.16, 0.13 and 0.10 mfd.); the influence of resistor R_1 on the relationship between the difference voltage ΔU and input voltage U (for $R_1 = 0$, 1, 2, 5 kilohms--latter curve checked satisfactorily with calculated curve for $R_1 = 5$ kilohms); and the difference voltage ΔU versus input voltage U for $R_1 = 0$ and various values for the load resistor R (R = infinity, R = 30 and 20 kilohms).

Equations were derived for U_2 and its derivative (in the simple series case), for ΔU with full compensation for phase distortion (caused by losses in the barium titanate condensers) and power in the diagonal (approximate). Analysis of the latter equation showed that if the capacitance of C_1 and C_2 is increased n times, the output power also increases by n times.



Circuit Diagram of Dielectric Stabilizer Used in the Experiments

The nonlinear barium titanate condenser, as with all nonlinear circuit elements, causes distortions in the voltage waveform which can be taken into account in the analytical solution of the differential equation which describes the processes in the above circuit. Oscillograms of the output voltages of the dielectric stabilizer and ferroresonant stabilizers of various systems showed that the distortion of sinusoidal voltage caused by the dielectric stabilizer is no worse than that caused by other types. At lower output voltages of the dielectric stabilizer, stable conditions can be obtained with considerable less voltage distortion.

CONFIDENTIAL

Sanitized Copy Approved for Release 2011/10/12 : CIA-RDP80-00809A000600280611-2

50X1-HUM

CONFIDENTIAL

CONFIDENTIAL

The development and manufacture of the first model of the dielectric stabilizer showed that, for an output of 50 watts, it can be made about the same size as a ferroresonant stabilizer, and its efficiency is considerably higher, since it depends mainly on the efficiency of the transformer.

The losses in the differential circuit itself are mainly due to the dielectric losses in the barium titanate condensers. When the tangent of their dielectric-loss angles is 0.04, the efficiency of the differential circuit approaches 100 percent; the efficiency of transformer, on the other hand, is about 98 percent.

Measurements of stabilization factors of the dielectric stabilizer and of three ferroresonant stabilizers (widely used at present for stabilizing the output voltage of measuring instruments) showed the following results: dielectric stabilizer--0.000; ferroresonant stabilizers: EPA-15 (Soviet) - 0.058; 162-A (American)- 0.068; Siemens E Srg[1] (German) 0,110.

The above data shows that the Soviet ferroresonant stabilizer gives the best stabilization but that the dielectric stabilizer, as regards quality of stabilization, is not inferior to ferroresonant stabilizers (American and German).

The advantage of a dielectric stabilizer as compared with a ferroresonant one is in its aperiodicity, which makes it insensitive to frequency oscillations. Moreover, the manufacturing technology for the dielectric stabilizer is simple in principle. The field of application of dielectric stabilizers, as with ferroresonant ones, is fairly wide (stabilization of low power circuits, input voltage of measuring instruments). The dielectric stabilizer can also be used in the high frequency range since barium titanate retains its nonlinearity over a wide range of frequencies.

Bibliography

1. B. M. Bul, Elektrichestvo, No 3, 1946

B. M. Bul and I. M. Gol'dman, DAN SSSR 46, No 4, 154, 1945

2. V. P. Vologdin, Elektrichestvo, No 8, 1947

3. H. L. Donley, RCA Vol VIII, No 3, September 1947

- E N D -

CONFIDENTIAL

CONFIDENTIAL